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Catalog of State-Level GHG Reduction Policy Options Agriculture, Forestry, and Waste Management

Prepared by the Center for Climate Strategies (CCS) for the Vermont Governor’s Commission on Climate Change Plenary Group (GCCC-PG) and the Technical Work Group (TWG) based on actions undertaken or considered by all US states.

Key to Future Rankings of Options in the Table that Follows:

Potential Emission Reductions ^{1/}	Potential Cost or Cost Savings ^{1/ 2/}
High (H): At least 100,000 Metric Tons (Mt) carbon dioxide equivalent (CO ₂ e) per year by 2020 (~1% of current MT emissions)	High (H): \$50 per Metric Ton CO ₂ e (MtCO ₂ e) or above
Medium (M): From 10,000 to 100,000 Mt CO ₂ e per year by 2020	Medium (M): \$5-50/MtCO ₂ e
Low (L): Less than 10,000 Mt CO ₂ e per year by 2020, or 100,000 Mt CO ₂ e by 2050	Low (L): Less than \$5/MtCO ₂ e
Uncertain (U): Not able to estimate at this time	Uncertain (U): Not able to estimate at this time
^{1/} Several measures may overlap in terms of emissions reductions and/or cost impacts. Estimates assume measures would be implemented independently from other measures.	
^{2/} Costs are denoted by a positive number. Cost savings (i.e., “negative costs”) are denoted by a negative number.	

Definition of “Priorities for Analysis”:

- **High:** High priority options will be analyzed first.
- **Medium:** Medium priority options will be analyzed next, time and resources permitting.
- **Low:** Low priority options will be analyzed last, time and resources permitting.

Notation of Options: Options will be marked with an asterisk (*) at a later date to indicate options that are at least partially “base case” policies, i.e., that have been considered or undertaken at some level in Vermont.

Potential State Actions - Agriculture, Forestry, & Waste Management (AFW)

Option No.	GHG Reduction Policy Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Additional Impacts, Feasibility Considerations	Notes
AFW-1	AGRICULTURE – PRODUCTION OF FUELS AND ELECTRICITY					
1.1	Manure Digesters/Other Waste Energy Utilization *		Medium	Neg to Low	<ul style="list-style-type: none"> Linked with Option 2.2 below 	<ul style="list-style-type: none"> CVPS “Cow Power” & other smaller projects
1.2	Biodiesel Production (incentives for feedstocks and production plants)		Low	?	<ul style="list-style-type: none"> Can be produced from both virgin and waste vegetable oils Cost dependent on design of incentives 	<ul style="list-style-type: none"> Being looked at by Vermont Biofuels Assoc.
1.3	Biomass Feedstocks for Electricity or Steam/Heat Production *		Medium	Low	<ul style="list-style-type: none"> Need to identify viable feedstocks 	<ul style="list-style-type: none"> Includes both residues and purpose-grown crops
1.4	Ethanol Production		Medium to High	?	<ul style="list-style-type: none"> Costs dependent on structure of incentives program 	<ul style="list-style-type: none"> Starch-based ethanol has small GHG benefits, while cellulosic ethanol has much higher benefits due to the energy required for ethanol production Additional benefits can be achieved through capture of CO₂ during fermentation
AFW-2	AGRICULTURE – FERTILIZER AND MANURE MANAGEMENT					
2.1	Nutrient Management (improve efficiency of fertilizer use) *		Low to Medium	Low	<ul style="list-style-type: none"> Significant opportunities beyond current practice? 	<ul style="list-style-type: none"> Agency of Agriculture programs
2.2	Manure Management (improve application methods) *		Low	?	<ul style="list-style-type: none"> May not be sufficient scientific basis supporting N₂O reductions 	<ul style="list-style-type: none"> Agency of Agriculture programs Can result in lower ammonia emissions. Could involve less application of manure to fields

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2.3	Manure Composting *		Low	Low to Medium	<ul style="list-style-type: none"> Not clear whether reductions in CH4 come at the cost of increases in N2O 	<ul style="list-style-type: none"> Agency of Agriculture programs Can result in lower ammonia emissions
2.4	Change Feedstocks (optimize nitrogen for N ₂ O reduction and enteric CH4 reduction)		Low	High	<ul style="list-style-type: none"> Co-benefits include ammonia emission reductions 	<ul style="list-style-type: none"> Option includes supplements to reduce CH4 from enteric fermentation, as well as nitrogen efficiency to reduce downstream N2O.
2.5	Reduce Non-Farm (Residential and Commercial) Fertilizer Use		Low	?	<ul style="list-style-type: none"> Emissions from non-farm application are not currently in the inventory; unclear what the costs would be. 	<ul style="list-style-type: none"> Additional research needed on the levels of N2O emissions from lawns, golf courses, etc.
AFW-3	AGRICULTURE – SOIL CARBON MANAGEMENT					
3.1	Conservation Tillage/No-Till (carbon sequestration and reduced energy use)		Medium to High	Low	<ul style="list-style-type: none"> Significant opportunities beyond current practice? 	<ul style="list-style-type: none"> Need estimates on current practices/potential for increased acreage.
3.2	Reduce Summer Fallow (increase soil C content, reduce N ₂ O emissions)		Low	Low	<ul style="list-style-type: none"> Significant opportunities beyond current practice? 	<ul style="list-style-type: none"> Need estimates of fallow summer acreage
3.3	Increase Winter Cover Crops (increase soil C and/or N content)		Low	Low	<ul style="list-style-type: none"> Significant opportunities beyond current practice? 	<ul style="list-style-type: none"> Need estimates of winter acreage available for cover crops
3.4	Improve Water and Nutrient Use (to minimize soil C loss)		Low	Low	<ul style="list-style-type: none"> Significant opportunities beyond current practice? 	
3.5	Rotational Grazing/Improve Grazing Crops and/or Management		Low	Low	<ul style="list-style-type: none"> Is impaired rangeland an issue in VT? 	

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3.6	Incentives for Maintenance of Conservation Reserve Program (CRP) Acreage		Low	?	<ul style="list-style-type: none"> Are there significant CRP acres being retired in VT? 	<ul style="list-style-type: none"> Costs are dependent on the design of the incentives program Option protects carbon on existing CRP acres that are projected to enter back into active production
3.7	Incentives for Establishing Windbreaks		Low	?	<ul style="list-style-type: none"> Size of the benefit dependent on the amount of windbreak acreage 	<ul style="list-style-type: none"> Benefits are achieved via higher above and below ground carbon stocks
AFW-4	AGRICULTURE – LAND USE CHANGE					
4.1	Convert Land to Grassland or Forest or Woody Shrubs		Low	Low	<ul style="list-style-type: none"> Available marginal agricultural acreage assumed to be limited 	<ul style="list-style-type: none"> Reductions dependent on available acreage and end use.
4.2	Preserve Open Space/Agricultural Land		Low	Medium to High	<ul style="list-style-type: none"> Reductions may or may not occur depending on above and below carbon levels and level of VMT reduction achieved 	<ul style="list-style-type: none"> VT Current Use Value Appraisal changes could be included here for additional ag and forestland protection Growth Center Bill would also impact this option.
4.3	Promote “No Net Loss” of Agricultural Land		Low to Medium	Medium to High	<ul style="list-style-type: none"> Essentially a more aggressive version of Option 4.2 	<ul style="list-style-type: none"> See VT Current Use Value Appraisal note above Growth Center Bill would also impact this option.
AFW-5	AGRICULTURE – FARMING PRACTICES					
5.1	Convert Diesel Farm Equipment to LNG/CNG, Hybrid Technology, or Biodiesel		Low	Medium to High	<ul style="list-style-type: none"> LNG/CNG engines or engine conversions reduce BC emissions 	<ul style="list-style-type: none"> Availability of diesel hybrid equipment for farm applications?

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5.2	Organic Farming *		Low to Medium	Low	<ul style="list-style-type: none"> • Reductions occur via lower intensity agricultural practices (nutrient/pesticide application, reduced tillage) 	<ul style="list-style-type: none"> •
5.3	Programs to Support Local Farming/Buy Local *		Low to Medium	?	<ul style="list-style-type: none"> • Reductions occur through lower transport related emissions. • Costs dependent on structure of incentives program 	<ul style="list-style-type: none"> • Virtual Farmer's Markets (e.g. Plymouth, NH) are a good example of an implementation method.
AFW-6	FORESTRY – BIOMASS PROTECTION AND MANAGEMENT					
6.1	Forest Protection – Reduced Clearing and Conversion to Nonforest Cover		Low to Medium	Medium to High	<ul style="list-style-type: none"> • Reductions are dependent on existing rates of clearing and conversion • Indirect benefit of promoting more efficient development 	<ul style="list-style-type: none"> • Current Use Valuation Appraisal applies to working forests; could be expanded to manage for C sequestration. • GHG sequestration rates for mature forests in VT versus younger forests need to be considered in this and other forestry options.
6.2	Afforestation and/or Restoration of Nonforested Lands		Low	Low to Medium	<ul style="list-style-type: none"> • Reductions are dependent on available acreage 	<ul style="list-style-type: none"> •
6.3	Reforestation/Restoration of Managed Stands		Low	Low to Medium	<ul style="list-style-type: none"> • Reductions are dependent on available acreage and existing stand health 	<ul style="list-style-type: none"> •
6.4	Increased Stocking of Poorly Stocked Lands		Low to Medium	Low to Medium	<ul style="list-style-type: none"> • Reductions dependent on acreage and stocking levels 	<ul style="list-style-type: none"> •

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6.5	Age Extension of Managed Stands		Low	Low	•	•
6.6	Thinning and Density Management of Managed Stands		Medium to High	Low to Medium	•	• Reductions occur via increases C sequestration and beneficial re-use of biomass.
6.7	Fertilization and Waste Recycling		Low to Medium	?	• Studies available for these practices in northern forests?	•
6.8	Expand Short Rotation Woody Crops (for fiber and energy)		Medium to High	Neg to Low	• Reductions depend on available acreage, distance to end use	•
6.9	Expanded Use of Genetically Preferred Species		Low	Low	• Opportunities available in VT?	• TWG members don't see significant potential for this option in VT.
6.10	Modified Biomass Removal Practices (reduced decay and energy use)		Low to Medium	Low to Medium	• Reductions depend on available acreage, technology employed and distance to end use	•
6.11	Fire Management and Risk Reduction Programs		Low to Medium	Low	• Reductions depend on available acreage, biomass density, and distance to end use	•
6.12	Ecosystem Health Risk Reduction Programs (pest/disease, invasive species) *		Low	Low to Medium	•	• Agency of Natural Resources
6.13	Drought Management Programs (tree selection, placement, protection) *		Low	Low	•	• Agency of Natural Resources • TWG members don't see significant potential here.

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6.14	Flood and Riparian Management Programs (tree selection, placement, protection) *		Low	Low to Medium	•	• Agency of Natural Resources
6.15	Watershed Management Programs (stand retention, enhancement and management) *		Low	Low to Medium	•	• Agency of Natural Resources
6.16	Habitat Management Programs (stand retention, enhancement and management) *		Low	Low to Medium	•	• Agency of Natural Resources
6.17	Promote Use of Fuel-Efficient Equipment or Alternative Fuels		Low	Low to Medium	•	•
AFW-7	MANAGEMENT OF DEVELOPED (NON-FORESTED) AREAS					
7.1	Enhanced Biomass Production in Existing Urban and Residential Trees		Low	Low to Medium	•	•
7.2	Tree Planting in Developed Areas		Low	Low to Medium	•	•
AFW-8	FORESTRY - WOOD PRODUCTS AND WASTE					
8.1	Improved Mill Waste Recovery and Use		Low	Low	•	•
8.2	Improved Logging Residue Recovery		Low	Low	•	•
8.3	Expanded Use of Durable Wood Products		Low to Medium	?	• Costs dependent on costs of materials to be substituted	• Includes furniture and other durable wood products

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8.4	Expanded Use of State and Locally-Grown Wood Products		Low to Medium	?	<ul style="list-style-type: none"> Costs dependent on embedded CO2 in imported wood products 	<ul style="list-style-type: none">
8.5	Residential Slash/Open Burning Alternatives		Low to Medium	?	<ul style="list-style-type: none"> Reductions dependent on available beneficial re-use (e.g. energy) Costs dependent on technology and distance to end user 	<ul style="list-style-type: none">
AFW-9	FORESTRY – ENERGY PRODUCTION					
9.1	Expanded Use of Forest Biomass Feedstocks for Electricity (fuel switching)		Medium to High	Low to Medium	<ul style="list-style-type: none"> Available present or future biomass electricity capacity in VT? 	<ul style="list-style-type: none">
9.2	Expanded Use of Forest Biomass Feedstocks for Residential, Commercial, Institutional, or Industrial Heating *		Medium to High	Neg to Low	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Residential, municipal (schools) applications, etc. Existing State incentive programs covering schools and municipal applications Home heating assistance program applicable?
9.3	Improved Efficiency of Wood Burning Stoves and Direct Heat		Low	Medium to High	<ul style="list-style-type: none"> Also achieves reductions in VOC, PM and CO. 	<ul style="list-style-type: none"> e.g. Wood-stove change-out programs Home heating assistance program applicable?
9.4	Improved Energy Capture from Wood Waste Combustion		Low to Medium	?	<ul style="list-style-type: none"> Technology, application, and market dependent costs. 	<ul style="list-style-type: none">
9.5	Expanded Landfill Methane Recapture (wood products waste)		Low to Medium	Neg to Low	<ul style="list-style-type: none"> Limited opportunities in VT, aside from one large flared site. 	<ul style="list-style-type: none"> Also represented under AFW-11

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9.6	Improved Commercialization of Biomass Gasification and Combined Cycle *		Low to High	?	<ul style="list-style-type: none"> • Reductions are dependent on size and number of applications • Costs dependent on structure of incentives 	<ul style="list-style-type: none"> •
9.7	Biofuels Production from Forest Residue		Low to High	?	<ul style="list-style-type: none"> • Benefit dependent on amount of residue diverted to fuel 	<ul style="list-style-type: none"> • New technologies being developed for portable ethanol production in the field
AFW-10	WASTE MANAGEMENT – WASTE MANAGEMENT STRATEGIES					
10.1	Advanced/Expanded Recycling and Composting		Low	Low to Medium	<ul style="list-style-type: none"> • Important element is the amount of additional energy required by the program 	<ul style="list-style-type: none"> • Could include expansion of recycling programs to rural areas. • Zero-Waste Programs could incorporate all of the AFW-10 Options as elements (Central VT Solid Waste District as an example).
10.2	Advanced Municipal Solid Waste Management Practices (e.g., bioreactors)		Low	Neg to Low	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> •
10.3	Source Reduction Strategies		Low	Low	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Could include life-cycle requirements for manufacturers requiring them to take back the product after its useful life
10.4	Resource Management Contracting		?	?	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Requires waste haulers to recycle portions of the waste collected.
10.5	Pricing Programs to Reduce Waste Generation		Low	?	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Pricing programs for waste paper cups, plastic bags, etc. to reduce generation and promote alternatives.
AFW-11	WASTE MANAGEMENT – LANDFILL GAS STRATEGIES					

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11.1	Flare Landfill Methane at non-NSPS (smaller) sites *		Low	Medium to High	<ul style="list-style-type: none"> Landfill gas emissions at uncontrolled sites are fairly low and decreasing 	<ul style="list-style-type: none">
11.2	Convert Landfill Methane to Electric Power, Space Heat, or LNG *		Low to Medium	Neg to Low	<ul style="list-style-type: none"> Limited opportunities in VT, aside from one large flared site. 	<ul style="list-style-type: none">
AFW-12	WASTE MANAGEMENT – WASTEWATER ACTIVITIES					
12.1	Energy Efficiency Improvements *		Low	Neg to Low	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Efficiency Vermont-funded turbine at Essex Junction wastewater treatment facility On-site low impact hydro for generating electricity
12.2	Lower Waste Processing Needs (lower water consumption, waste production) *		Low	?	<ul style="list-style-type: none"> Costs are industry and technology specific 	<ul style="list-style-type: none"> Lower water consumption component of water supply plans
12.3	Install Digesters and Energy Plant *		Low to Med	Med to High	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Energy plant could be a gas turbine, boiler, or fuel cell Efficiency Vermont-funded turbine at Essex Junction wastewater treatment facility